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THE FOSSIL BUTTERFLIES OF FLORISSANT.

BY SAMUEL H. SCUDDER.

INTRODUCTION.

Having examined more than ten years ago all the butterflies that were known in the European Tertiaries—very few in number—the American forms that have been exhumed at Florissant, in Colorado, in presumably Oligocene beds, have especially interested me. Two of these I owe to the kind communication of friends; the others have been obtained by myself on different occasions. There are, altogether, seven species, more than have been found at any other locality in the world, and only two less than all that are known in the imago state from European deposits. Five of the seven belong to the subfamily *Nymphalinae*, which claims only one of the European species, *Eugonia atava*. One of the others belongs to the subfamily *Pierinae*, represented in European Tertiaries by three species. The last represents a nearly extinct type, the subfamily *Libytheinae*, and is of especial interest. The subfamily *Satyrinae* and the family *Hesperiidae*, each of them with two representatives in the European tertiaries (the *Satyrinae* also by a caterpillar presumed to belong here), and the subfamily *Papilioninae*, with a single member in the beds at Aix, France, are wholly unrepresented, thus far, in American deposits.

The species all belong to extinct genera; those referred to the *Nymphalinae* are, with one exception, closely allied, and three of them are more nearly related to one another than to any living type. The existing allies of all of them are now to be sought in Central or South America, unless we look for the friends of one among the inhabitants of the warmer parts of the Old World. The Pierid, however, is as close to our ordinary cabbage butterfly, (imported from Europe, but with other species of the same genus already existing here) as it is to anything found in warmer climates, while the species belonging to that aberrant group, the *Libytheinae*, is specially curious, as it resembles least of all the American species of the subfamily, and most of all one that occurs in western Africa. The general aspect, therefore, of the Florissant butterfly fauna is distinctly subtropical and American, while the Tertiary butterfly fauna of Europe is derived in the first place¹ from the East Indies, in the second from subtropical America and in the third from home.

¹See my Fossil Butterflies, Mem. Am. Assoc. Adv. Sci., I, 1875.

There is a single point in the structure of our Florissant butterflies to which it is worth while to direct attention. In living butterflies, as we ascend the scale of families we find an increasing atrophy of the front legs. In the two lower families, *Hesperiidae* and *Papilionidae*, they are similar in structure to the other pairs, being normally developed. In the *Lycænidae* (including in this the subfamilies *Lemoniinae* and *Lycæninæ*) they are atrophied in the male to a greater or less extent, with the loss of the terminal armature, while still perfect in the female. In the highest family, *Nymphalidae*; with the single exception of the little group *Libytheinae*, which agrees with the *Lycænidae*, they are aborted in both sexes, often to an excessive extent. Now, in *Prolibythea* we have the forelegs of the female preserved, and in *Nymphalites* the foreleg of the male; in both cases they agree in all essential points with what we should expect to find in living forms belonging to the same groups, showing that at the earliest epoch at which butterflies are yet known these peculiar differences, marking the upward progression of forms, were already in existence. We must therefore look for the proofs either of great acceleration in development when butterflies first appeared or of the existence of butterflies at a far earlier period than we yet know them.

CLASSIFIED LIST OF KNOWN FOSSIL BUTTERFLIES.

The following is a classified list of the fossil butterflies of the world, as known up to the present time, with the localities from which they come. Of the European beds, Aix is the oldest and is referred to the Oligocene, Rott to the Lower Miocene, and Radoboj to the Middle Miocene.

Classified list of fossil butterflies.

(Genera still living are italicised.)

Family.	Subfamily.	Tribe.	Genus.	Species.	Locality.
<i>Nymphalidae</i>	<i>Satyrinae</i>		<i>Neorinopsis</i>	<i>Sepulta</i> (Boisduval)	Aix.
			<i>Lethites</i>	<i>Reynesii</i> Scudder	Aix.
			[<i>Satyrites</i>	<i>Incertus</i> Dandén (larva)	Aix.]
	<i>Nymphalinae</i>	<i>Vanessidi</i>	<i>Eugonia</i>	<i>Atava</i> (Heer)	Radoboj.
			<i>Prodryas</i>	<i>Persephone</i> Scudder	Florissant.
			<i>Jupiteria</i>	<i>Charon</i> Scudder	Florissant.
			<i>Lithopsyche</i>	<i>Styx</i> Scudder	Florissant.
			<i>Nymphalitis</i>	<i>Obscurum</i> Scudder	Florissant.
			<i>Apanthesis</i>	<i>Leuce</i> Scudder	Florissant.
<i>Papilionidae</i>	<i>Libytheinae</i>		<i>Prolibythea</i>	<i>Vagabunda</i> Scudder	Florissant.
	<i>Pierinae</i>	<i>Rhodoceridi</i>	<i>Mylothrites</i>	<i>Pluto</i> (Heer)	Radoboj.
			<i>Collates</i>	<i>Proserpina</i> Scudder	Aix.
		<i>Pieridi</i>	<i>Stolopsyche</i>	<i>Libytheoides</i> Scudder	Florissant.
	<i>Papilioninae</i>	<i>Parnassidi</i>	<i>Pontia</i>	<i>Freyri</i> (Heer)	Radoboj.
			<i>Thaites</i>	<i>Ruminiana</i> (Heer)	Aix.
			<i>Thanaosites</i>	<i>Vetula</i> (Heyden)	Rott.
		<i>Pamphilidi</i>	<i>Pamphilites</i>	<i>Albula</i> Scudder	Aix.
<i>Hesperiidae</i>					

from the middle branch of the median. The internal nervule can not be determined.

The abdomen is full, with the third and fourth joints longest, the whole nearly twice as long, and in the middle fully as broad as the thorax.

PRODRYAS PERSEPHONE.

(Pl. LII, Figs. 1-10.)

Prodryas persephone Scudd., Bull. U. S. Geol. Survey Terr. vol. 4, pp. 524-526 (1878).

The single specimen found is in a wonderful state of preservation, the wings expanded as if in readiness for the cabinet and absolutely perfect, with the exception of the tail of the right hind wing. The thorax and abdomen are perfectly preserved, but indications only of the legs are seen beneath the wings. The head is twisted so as to throw both antennæ upon one side and to exhibit the palpi better than would otherwise be the case. The tongue is doubtless preserved, but the danger of injuring the palpi prevents me from chipping the stone to find it. The antennæ are nearly perfect, but the stalk is covered with a thin film of stone, which will not scale, and thus conceals the joints. The markings of the wings are perfectly preserved, but on the costal area of the hind wings are partially concealed by the overlapping of the fore wings. In almost all the darker parts of the wings the form of the scales even can be determined under the microscope (Pl. LII, Figs. 5-9). This I was unable to do in any of the European fossil butterflies, although in some of them the points where they were inserted could be seen; nor have I been able to satisfactorily determine their form on any of the other species here described.

The wings are rather dark brown, deepening in tint on the front wings toward the extreme base and along the immediate costal edge, ornamented with pale markings, which were probably bright colored in life. Fore wings with a mesial transverse, slightly arcuate band, extending across the wing at right angles to the costal border, just failing to reach either margin, divided by every nervule, its inner margin continuous and nearly straight, its outer strongly crenulate, being gently convex in the discoidal cell (more below than above), strongly convex in the lower median and submedio-internal interspaces, and strongly sinuous in the medio-submedian interspace; its upper extremity is before the middle of the wing, and incloses in its middle the base of the first superior subcostal nervule; its outer border is bent inward below the cell, exactly to the last divarication of the median nervule, and it reaches the anal area of the wing two-thirds the distance from the base. A row of five unequal pale spots crosses the wing in a straight line, extending from the lower outer angle to

the costal margin at two-thirds the distance from the base; four of these are approximated in the subcostal interspaces; the fifth and largest is in the middle of the upper median interspace, but nearer the middle than the upper median nervule; it is broadly ovate and obliquely placed, subparallel to the mesial band, its broader extremity above; the lower of the subcostal spots, before the middle of the lowest subcostal interspace, is obovate, still more oblique, pointing toward the upper of the subcosto-median spots to be mentioned, and only a little smaller than the median spot. The three spots above this are equal, about half as large as the latter, twice as long as broad, rounded, subquadrate, each occupying nearly the breadth of the subcostal interspaces next succeeding; the upper two appear as a single spot, being scarcely divided by the intervening third superior subcostal nervule. Still nearer the outer margin of the wing, and parallel to the row of spots just mentioned, are two subequal, rounded, obovate spots, slightly broader than long, the upper a little the larger, together occupying the entire breadth of the subcosto-median interspace, removed by less than twice their width from the row of spots previously mentioned; the fringe of the wing appears to be slightly darker than the ground-color.

Hind wings with a very large pale spot occupying the entire upper outer angle of the wing, reaching from the outer margin nearly halfway to the base, and from the costal margin to the upper median nervule; its basal margin is convex in the subcosto-median interspace, following what would perhaps naturally be the outer limits of the cell, while on either side of the lowest subcostal nervule the spot is separated from the outer margin of the wing by a narrow dark edging. On the irregular border which faces the median nervure, this pale spot emits three long, more or less sinuous tongues of pale color; one a very narrow, nearly straight stripe or line along the margin itself, which extends only to the elongated upper median nervule, the breadth of the spot being less toward the margin than in the middle of the wing; a second, subparallel to the outer border, and therefore arcuate, as well as slightly sinuous, subequal, more or less broken into transverse spots, extending to the inner margin, and distant beyond the middle median nervule about half an interspace's width from the outer margin; beyond the submedian it is very faint, and above it the spot is broader; the third, slightly narrower, subparallel to the second, but running more nearly at right angles to the nervules, extends in a slightly sinuous course across the median interspaces only, tapering apically. In addition to these markings, there is a series of submarginal pale dots in the lower half of the wing, one in the narrow (upper median) and two in each of the broader interspaces, besides a larger roundish or subtransverse dark spot, deepening centrally in color, in the medio-submedian interspace, between the submarginal pale dots and the middle tongue

of the large pale spot, which here tend to inclose the dark spot in an annular pale ring, and give it the appearance of a rather obscure ocellus. Above the tail, the fringe appears to be concolorous with the pale ground; below it, darker than the adjoining dark ground-color.

The scales on the outer half of the fore wing (Pl. LII. Figs. 5-9) are two or three times as long as broad, with straight parallel sides, a well-rounded base, and a deeply combed, often strongly arcuate apex, consisting of from three to five, usually four, entirely similar, equidistant, tapering, finely pointed teeth, of equal length, or the middle ones slightly larger, the outer ones at the edges of the scale, all nearly a third as long as the scale itself.

Length of body, 22^{mm}; of palpi, 2.4^{mm}; last joint of same, 1.3^{mm}; of antennæ, 10.5^{mm}; of club of same, 2.5^{mm}; breadth of latter, 0.85^{mm}; length of thorax, 6.5^{mm}; its breadth, 5.5^{mm}; expanse of wings, 54^{mm}; length of front wing, 24.5^{mm}; its outer margin, 18^{mm}; its inner margin, 15^{mm}; breadth of wing, 14.5^{mm}; length of hind wing, excluding tail, 18^{mm}; additional length of tail, 3.25^{mm}; breadth of latter at base, 1^{mm}; in the middle, 0.55^{mm}; greatest breadth of hind wing, 16.75^{mm}; length of abdomen, 13^{mm}; breadth of same, 5^{mm}.

Florissant, one specimen, No. 394.

This is the first butterfly fossil found in America, and as only nine species are known in the imago state from the well-worked Tertiary strata of Europe, it may properly be esteemed an especial rarity. Besides this it has a double value: first, in that it is far more perfect than any of the European specimens (nearly all of which I have seen) or than any other of the species here described; and, second, in presenting, as none of the others do to any conspicuous degree, a marked divergence from living types, combined with some characters of an inferior organization. When first received, the tails of the hind wings and the tips of the antennæ were hidden by flakes of stone, and it was taken, both by myself and by every entomologist to whom I showed it, to be a Hesperian, the lowest family of butterflies. The neurulation, however, which, although mostly very obscure, can be determined with certainty, shows it to be a Nymphalid, the highest family, with which the structure of the antennæ and palpi and the outline of the hind wings, now entirely uncovered, perfectly agree. The first inference was drawn principally from the robustness of the body and the form, proportions, and markings of the fore wings. The latter are unusually long for a Nymphalid of this type, have a remarkably straight costa, an outer border bent at the middle instead of far above it, and are possessed of a nearly transverse, median, light-colored belt on a dark ground, a subapical row of small spots depending from the costa, a spot in continuity with them in the upper median interspace, and beyond them, parallel to the outer border, in the costo-subcostal interspace, a pair of minute spots—

(Heer), in which the markings may be looked upon as less highly developed than in the living types.

Instances could, of course, be easily given from among living types in which the ornamentation of the upper surface is less variegated in the fore wings than in the hind pair, but it might readily be doubted whether this should be looked upon as having any direct bearing upon this subject; yet, even if none could be cited, it might fairly be urged that the lapse of time since the Florissant beds were deposited is amply sufficient for the loss of any such indication of hesperidiform affinities in a group of insects so pliable in ornamentation as butterflies are shown to be by the mere facts of mimicry.

Prodryas shows further peculiarities when compared with its nearest living allies. In the tropical American genus *Hypanartia*, which seems to be its nearest neighbor, as in all those closely allied to it at the present day, the costal margin beyond the base is uniformly arched throughout; and the outer margin, angulated in the upper half of the wing, is roundly excised below it, giving the European allies of these butterflies the common name of "angle wings." They are insects of strong and rapid flight, capable of the most abrupt and unanticipated movements, making them very difficult of capture on the wing. The straight, strong costa and more elongated wing of *Prodryas*, on the other hand, with its nearly uniform, straight outer border, combined with the robustness of the body, indicate great strength of wing and a rapid direct flight, as in the *Hesperidae*, but not the power of sudden turning.

In *Hypanartia* and its immediate allies, the cell of the front wing is closed, although by a feeble vein, and the superior subcostal nervules take their rise at more or less irregular distances apart, and run long distances crowded side by side; while in *Prodryas* the cell is open, and the subcostal nervules are much shorter and very uniform in their distribution; the inferior subcostal nervules also originate in *Prodryas* in a much simpler fashion, indicating that its ancestors never had the cell closed, although a foreshadowing of the closure may be seen in a row of special scales (or a line of color) at the supposititious termination of the cell. That this can hardly indicate a true vein appears from the fact that there is not the slightest tendency of the opposing veins to approach each other at its extremities, a tendency which it would seem should naturally precede the formation of a vein; the second inferior subcostal nervule takes its rise from the first in just about the same manner as the second superior nervule originates from the main stem, neither its basal portion nor that of the first inferior nervule showing any noticeable tendency to bend abruptly and to help form the termination of the cell, as now appears in all *Vanessidi* to a greater or less extent, and which, in some open-celled genera, seems to indicate the loss of a transverse discoidal veinlet after a previous possession. The presence of a

transversely disposed pair of spots in the costo-subcostal interspace also indicates the probability that this interspace had hitherto never been narrower nor bridged by a vein.

In the hind wings there are two features of importance besides the unusual openness of the cell, which is scarcely narrowed apically. The first is the course of the first subcostal veinlet, which originates far toward the base of the wing, and terminates where the costal nervure is sure to end, in nearly all *Vanessidi*,¹ at the upper outer angle of the wing. This necessitates a shortening of the costal nervure. I do not know of a single instance of such a feature among the members of this group of *Nymphalide*, but it is an almost persistent character in the *Pterina*, and very common in the *Satyrinae*. The other point is the extreme narrowness of the upper as compared with the lower median interspace, the former being scarcely more than half as broad as the latter, owing to the slight divergence and continual proximity of the outer branches of the median vein. The only other feature in which it differs unusually from its allies is in the brevity of the antennæ.

JUPITERIA, gen. nov.

Allied to *Prodryas* and *Jinonia*. Fore wings (Pl. LII, Fig. 14) triangular, with a somewhat pointed tip, the costal margin gently and regularly convex, the outer margin entire and straight, and the inner margin straight. Hind wings subcircular, longer than broad, the costal border slightly concave, much as in *Eunica*, the outer margin crenulate, perhaps prolonged into a tail near the lower median nervule, the inner border not very full.

Costal vein of fore wings terminating about the middle of the border; subcostal vein terminating some distance below the tip of the wing, bending downward from its outer branch; first superior nervule thrown off long before the first inferior nervule; second, third, and fourth at equal and wide distances apart beyond the first inferior, the fourth about midway between the origin of the latter and the tip of the wing; first inferior nervule parting rather widely and regularly from the main branch beyond the origin of the middle median nervule, second inferior branch arising from the first at a little distance from its base and at once separated widely from and running parallel to it; cell apparently open. Last median branch bent at base as if to connect with a discoidal nervule and running nearer the adjoining subcostal nervule than the neighboring median nervule. Submedian nervure near the inner margin.

Costal vein of hind wing running, as in *Eunica*, very close to the margin. Subcostal branches arising at a moderate distance apart, the second at a considerable distance before the first median branch.

¹In *Polignia* and some of its immediate allies the upper outer angle of the hind wing is curiously excised, throwing the costal nervure back some distance.

Median nervules equally and widely distant near their base, the last curving as if to close the cell, opposite a point just before the middle of the lower subcostal nervule.

This genus is perhaps nearer to *Prodryas* than to any existing type, though it is still nearer to *Lithopsyche*. From the former it differs in the basal breadth of the lower two subcostal and last median interspaces, in the approximation of the adjoining subcostal and median nervules and the approximation of the submedian nervure to the margin of the front wing; in the hind wing it differs greatly both in form and the course of the nervures. From *Lithopsyche* it differs in the narrower fore wing, the approximation of the subcostal nervure to the costal border, the equal separation of the bases of the superior sub-costal nervules, the later origin of the inferior subcostal nervule as compared to the median, the wider basal divergence of the first inferior subcostal nervule, the open and narrower cell, and the straight inner margin. The hind wing further differs in its greater comparative length, the excised costal margin and close approximation to it of the costal nervure, the earlier and less distant branching of the subcostal nervules, all of which arise before the first branch of the median, the possible caudal appendage at the inner angle of the wing and its narrower inner lobe.

Concerning its relations to living types, the hind wing, excepting the possible tail, resembles remarkably, both in form and neurulation, that of *Eunica*, a genus of the neighboring tribe of *Nymphalidi*, but the branching of the middle veins of this wing is much later in the fossil form; the fore wing, on the other hand, is very different, both in the open and much longer cell, and in the origin of the second superior subcostal nervule, in which it agrees better with most of the *Tanessidi*. The neurulation of the hind wing, excepting of the costal vein, is very close to that of *Junonia*, in which also there is a slight extension of the lower median nervule and the submedian nervure; but in the front wing we have here considerable differences in the longer cell, due to the later origin of the inferior subcostal nervules, the second of which arises at some distance beyond the first, and not at the point of its origin; while, further, the relation of the second superior subcostal nervule is very different from what it is in the fossil species, being approximated to the first and arising before the end of the shortened cell, as in *Eunica*. The straight outer margin of the front wing, the excised costal border, and the normal extension of the first median nervule of the hind wing separate it at once from *Hypanartia*, from which in its neurulation it is not remotely distant; for instance, it has a strong resemblance in the length and general relation of the cell of the front wing, though not in its closure; but here, as elsewhere, the relations of the second superior subcostal nervule are different. Indeed, it would appear as if *Jupiteria* and *Prodryas* belonged to a peculiar section of *Tanessidi*.

Hind wings of a rounded form, with the lower half of the outer margin broken in the single specimen seen, so that its form in that region can not be determined; but the length of the first median nervule leads to the conclusion that it bore a tail, probably like that seen in *Colobura*, and only slightly longer than the dentate prominence of the last median nervule. The costal margin has a small shoulder, beyond which it is very slightly concave. The upper half of the outer margin is well rounded and crenulate between the nervules. The inner margin is very obscure, but appears to be broadly convex.

The costal and subcostal nervures spring from the same point, the former being directed forward in a nearly straight line until the pre-costal is reached; this is short and only slightly curved, directed toward the angle of the costal shoulder; beyond the pre-costal nervure the costal runs in a nearly straight line, gradually approaching the margin, which it almost reaches at the middle of the margin, and then runs in very close proximity to it to the extremity of the margin. The subcostal nervure runs parallel to the costal margin as far as the origin of its first nervule, which, nearly continuing its course, passes in a broad sweep to the margin; the vein itself then bends downward parallel to the median nervure, running thus nearly as in its undivided stem, when the second and third nervules arise and pass with a sweep similar to that of the first nervule but diverging more and more from it. The median nervure runs in a straight line nearly to the middle and to only a little below the center of the wing, where the first nervule is thrown off; this bends a little downward and runs in a straight course to the margin; the vein then turns upward so as to be parallel to the base of the subcostal nervure, and at equal and wide intervals emits the other two nervules, which are almost equally straight; the point, however, where the third may be said to part from the main nervure (or the basal portion itself of the nervule) is very strongly curved, and approaches the lower subcostal nervule, with which it is in no way connected, the cell being open. Considering this point the end of the cell, the latter is considerably more than half as long as the wing. The submedian nervure is straight, runs widely distant from the median nervure, and its lowest branch, and terminates at the lower outer angle of the wing. The internal nervure is also straight and ends abruptly before the middle of the inner border.

Little can be said of the markings of the wings, because most of them are obscure and are in the region where the wings overlap, making it difficult to see whether they belong to the fore or hind wing. Judging from their position relative to the nervules, it would, however, appear more probable that they belong to the hind wing, although it must remain very doubtful, the more so as the portion of the hind wing not covered by the front wing presents no appearance of ornamentation, which it would be likely to have possessed.

though not necessarily, did the ornamentation seen belong to the hind wing. If the markings do belong to the hind wing it affords another example of the greater ornamentation of the hind than of the front wing. Possibly the markings of both wings are commingled in the lights and shades which appear. The general ornamentation may be stated as follows: The wings were of a dark color, with decided light colored small bars depending from the costal margin just beyond the middle, while the outer half of one or both wings was mottled with fainter, light colored, vaguely bounded, quadrate spots, collected to a certain extent into two or three rather distant transverse bands parallel to each other and to the outer margin. The only markings which can be definitely referred to one or the other wing are the costal spots. Those in the fore wing consist of a quadrate spot at about the end of the third fifth of the wing, its outer margin at the tip of the first superior subcostal nervule, falling very nearly (perhaps quite) to the first inferior subcostal nervule, and therefore nearly twice as deep as long; and a fainter, much smaller spot at the tip of the costal nervule, which is nearly circular. On the hind wing there are also two such spots, but they are equal and similar, excepting that the outer is the fainter, and both are smaller than the larger spot of the fore wing; both reach the upper subcostal nervule, and are about half as long as deep; the inner is situated with its interior edge at the middle of the costal margin, the outer separated from the inner by its own width.

No appendages of any importance can be seen. Only a few basal joints of the antennae are preserved, directed forward, with traces of the palpi in a somewhat confused condition, and slight projections next the base of the front wings, which are doubtless a part of some of the legs, perhaps the front pair. The abdomen reaches to a point rather more than midway between the tip of the internal and that of the submedian nervures, and is full and well rounded, rather indicating a female.

Length of body, 19^{mm} ; of fragment of fore wing, 24^{mm} ; probable entire length of same, 27^{mm} ; breadth of same, 15^{mm} ; distance from base of wing to tip of cell, 12^{mm} ; width of cell, 3.5^{mm} ; distance from base of hind wing to tip of lowest subcostal nervule, 20^{mm} ; same to tip of lowest median nervule, as far as preserved, 20^{mm} ; breadth of hind wing, 17^{mm} ; probable expanse of wings, 54^{mm} .

A single specimen from Florissant, Colo., in the collection of Mr. R. D. LaCoe, of Pittston, Pa., bearing the number 2,100, presents a view of the upper surface.

LITHOPSYCHE (*λίθος, ψυχή*), gen. nov.

Allied to *Jupileia* and *Hyperantia*. Fore wings (Pl. LII, Fig. 17) triangular, very broad, the costal margin uniformly convex, the outer margin straight; and the inner full toward the base. Hind

wings regular, rounded, with no upper angle, and a broadly guttered inner margin, the outer margin entire.

Costal vein of fore wings terminating before the middle of the margin. Cell about half as long as the wing, closed by a straight, strong vein. Subcostal nervure distant from the margin; the first three superior nervules emitted not far apart, long before the fourth, the first a little before the second at the origin of the first inferior nervule; this last originates about opposite the middle median nervule and does not part widely from the main vein for some distance; second inferior nervule arises close to base of first, but at once becomes widely separated from and then parallel to it, being angulate at tip of cell; last median much approximated to the lowest subcostal nervule, running considerably toward it, even beyond the tip of the cell; discoidal striking the median nervule as far beyond origin of second as the second is from the first median nervule. Submedian nervure near inner margin.

Subcostal branches of hind wings arising at a considerable distance apart, the last opposite a point midway between first and second median branches; median branches equally and widely distant next base, the last curved abruptly opposite a point just before the middle of the lowest subcostal nervule.

This genus is nearer *Jupiteria* than any living genus. It differs from it, however, in several prominent points. The fore wing is far broader with a less pointed apex and a full inner border; the cell of the same wing is distinctly closed; the subcostal nervure is distant from the margin, and its first three superior veins are clustered at a distance from the last; the second arises opposite instead of beyond the inferior nervules, the latter are also thrown inward as related to the median nervules, and the upper of them runs at first close to instead of parting from the main vein. In the hind wing the circular form is very different, with its full costal and inner margin and its uniform outer border; the costal vein does not hug the margin, while the subcostal branches, instead of arising before the median are nearly opposite them. It is still further removed from *Prodryas*, from which it differs in nearly all the points in which the latter differs from *Jupiteria* as noted under that genus, even in the differences mentioned as to the origin of the superior subcostal nervules of the fore wing.

Compared with existing types, it appears to agree far better with *Hypanartia* than with any other genus, but differs from it quite as widely as it does from existing neighboring genera. In the (most probably) straight and entire outer margin of the fore wing, its full almost lobed inner margin, and the exceedingly uniform rounded contour of the hind wing it differs strikingly from it. In the neurulation, also, there are important points of distinction; the costal nervure of the fore wing is much longer in *Hypanartia*, the subcostal nerv-

ure is not so distant from the margin, and the second superior nervule is much more closely approximated to the first and distant from the third, arising before the inferior nervules; the cell is closed by a vein which is continuous with and does not form a right angle with the base of the second superior subcostal nervule, and yet strikes the median nearer the middle branch than in *Lithopsyche*. In the hind wing of *Hypanartia* the subcostal branches originate much closer together and nearer to the base as compared with the median nervules, while the last median nervule is not so strongly bent and widely distant from the middle median nervule as in *Lithopsyche*.

In the markings of *Lithopsyche*, which are apparently those of the upper surface, I can find nothing whatever to compare with any existing type remotely connected with the fossil. The most conspicuous features of these markings, besides the costal and discoidal spots of the fore wing found in so many butterflies, are a pair of spots, one at the base of the upper median, the other ocellate, at the extremity of the lower median interspace of the fore wing; these are repeated in exactly similar relations in the subcostal interspaces of the hind wings, and are therefore undoubtedly translated correctly from the confusion of the overlapping wings (Pl. LII, Fig. 11). Such a combination with a mottled median area on the hind wings is altogether unique, so far as I can discover, among *Nymphalinee*. The only markings found on the fore wings not seen on the hind pair are the costal spots; while the only ones on the hind wings not repeated, in some sense, on the fore wings, are the mottlings of the median area, which, though much more extensive and complicated than that of the fore wings, does not add materially to the points urged in my account of *Prodryas*, concerning the relative ornamentation of the front and hind wings.

LITHOPSYCHE STYX, sp. nov.

(Pl. LII, Figs. 11, 16, 17.)

The wings, and those only of one side, are preserved. The hind wing is nearly perfect, but the apex of the fore wing is gone. The character of the venuration of this wing, however, coupled with the course of the margins of the wing, enables us to restore the form and even the missing veins with reasonable certitude, as given in Fig. 17. Assuming this restoration to be correct, the fore wing is half as long again as broad, triangular in shape, the costal margin regularly and gently convex (the tip bent but rounded), the outer margin nearly straight and entire, the inner margin nearly straight excepting for a broadly convex portion on the basal two-thirds. The costal nervure is short, terminating before the tip of the cell, or only a little beyond the tip of the second fifth of the margin.

The subcostal nervure is almost exactly parallel to the margin throughout; the first superior subcostal nervule originates just before

the end of the second fifth of the wing, and running parallel to but very distant from the costal nervure, terminates at the end of the second third of the wing; the second superior subcostal nervule originates just beyond the first, beneath the tip of the costal nervure, and terminates at a scarcely greater distance beyond the first than it had at starting; the third superior subcostal nervule originates a little beyond the middle of the wing, and runs parallel to the second; its apex is in the broken part of the wing, but is probably either not a great distance before the tip or midway between it and the tip of the preceding; the fourth superior subcostal nervule is wholly in the broken part of the wing, but from the wide divergence of the first inferior subcostal nervule is probably much as represented in the figure, originating about midway between the base of the third superior nervule and the outer border, and terminating at the tip of the wing; the first inferior subcostal nervule springs from the main vein directly opposite the base of the second superior nervule, parts from the main vein at first gently, afterwards rapidly, and must terminate near the middle of the upper half of the outer margin; the second superior subcostal nervule springs from the first inferior nervule almost at its origin, is deflected in a straight course toward the middle of the outer margin of the wing until it meets the vein closing the cell, with which it forms slightly more than a right angle, and where it is nearly as distant from the subcostal nervure as that is from the costal margin; it then turns abruptly and follows a curve like the first superior subcostal nervule, but slightly divergent from it. The median nervure is widely divergent from the subcostal nervure until it emits its first branch, which is straight, bent downward from the main nervure at a very broad angle, and originates at the end of the second third of the cell; beyond this branch the median nervure passes with a couple of nearly equal broad curves, the first parallel to the subcostal nervure, the second turned a little upward to meet the vein closing the cell, which is straight and a little shorter than the basal portion of the second inferior subcostal nervule; the second median nervule is straight, and so is the third beyond the base, which is strongly curved, continuing the course of the extremity of the main vein so as to bring the basal part of the third median nervule as near to the second inferior subcostal nervule as the latter is to the first inferior nervule, and giving to the whole median nervure a course almost exactly parallel to the nearer subcostal nervule. The submedian nervure is straight, widely distant from the median nervure and its first branch, and closely approximated to the inner margin, at the subangular termination of which it ends. The closed cell is about two-fifths the length of the wing and two and a half times longer than broad.

The hind wing is well rounded, with entire margin, a little longer than broad, the costal passing insensibly into the outer margin, and

the lower outer angle probably almost equally rounded, the edge of the wing, as preserved, being probably folded at this point. The base of the inner margin is broadly lobate, indicating that it formed a gutter for the inclosure of the abdomen. The costal margin is not very abruptly curved at the base, and the precostal nervure can not be made out; the former is tolerably distant from the margin.

The subcostal nervure and its first branch run in one scarcely curved continuous line parallel to the larger part of the costal nervure; at the origin of this branch, which is two-sevenths the distance from the base, the costal nervure turns abruptly downwards parallel to the median nervure and at a considerable distance on or opposite a point midway between the first two branches of the median forks, the middle branch passing in a very gentle curve, the lower by a gently sinuous course to the outer margin. The median nervure is at first directed toward the tip of its middle branch, and opposite a point midway between the bases of the first two subcostal nervures emits its first straight branch scarcely bent downward from the course of the previous portion of the main vein; the latter is then bent gently upward, this portion of its course being equal in length to the similar part of the subcostal vein, and then emits its middle straight branch and its outer branch, both subparallel to the first branch, but the latter roundly bent beyond the base and so approximated somewhat closely to the lower subcostal nervure at a point a little before the middle of the latter, with which, however, it is not at all connected, the cell being open. The submedian nervure is gently curved and terminates at the outer angle. The internal nervure terminates at the middle of the inner border.

Although the wings are almost completely overlapped (Figs. 11, 16), the markings of the two wings can be separated with considerable certainty by referring them to the interspaces of one or the other of them. On this basis they may be described as follows: The ground color of both wings was dark with lighter markings, which in the fore wings were distributed in moderate sized patches mostly in the middle of the upper half of the wing; on the hind wings clustered into irregular mottling, mostly in the lower half of the outer portion of the wing. On the fore wings the lighter patches consisted of two spots depending from the costal margin, one broad, opposite the middle of the cell and reaching only so far as it, with the exception of a slight middle extension into the top of the cell; the other only half as broad, half way between the first and the tip of the wing and reaching to the first inferior subcostal nervure; between these was also a faint cloud; a still narrower patch traversed the cell near its extremity; and near the base of the upper median interspace and filling it at that point was a large irregularly quadrate spot, infringing slightly on the lower median interspace at one corner, not crossing the interspace regularly, but having its sides placed more in re-

lation to the costal margin; in addition, in the outer half of the lower median interspace, is an obscure, irregular, rounded spot as large as the interspace, and perhaps obscurely ocellate.

On the hind wings few of the markings appear very pronounced; the most so are those situated above the cell. These are a round spot in the upper subcostal interspace, just beyond the base of the middle nervule and scarcely filling the width of the interspace; and an ocellus, perhaps imperfect above and with a large pupil, filling the lower subcostal interspace just before the margin. There is also a small roundish spot in the cell below the base of the middle subcostal nervule; another distinct and round or pyriform spot crosses the base of the upper median interspace. The rest of the markings of the wing are in the form of a nearly equal mottling of dark and light shades formed by irregular narrow light bars transverse to the interspaces, on a dark ground, which fill the outer third or quarter of the upper median, the outer two-thirds of the lower median, and the outer third of the medio-submedian interspace.

Length of fragment of fore wing, 23^{mm} ; its probable entire length, 27^{mm} ; breadth of same, 15^{mm} ; length of cell, 13^{mm} ; breadth of same, 4.25^{mm} ; length of hind wing, 20^{mm} ; breadth of same as preserved, 18^{mm} ; probable actual breadth, 19.5^{mm} .

The single specimen was obtained some years ago at Florissant, Colo., by Mr. Israel C. Russell, now of the U. S. Geological Survey, who has allowed me to study it.

NYMPHALITES OBSCURUM, gen. et sp. nov.

(Pl. LIII, Figs. 10-13.)

We apply this name to the most vaguely and imperfectly preserved of all our fossil butterflies, of which enough remains in sufficient preservation to indicate the family to which it belongs, and to some extent its closer affinities. It is preserved with spread wings, of which the borders are preserved only in the costal region, and the position of a few veins can be determined, without revealing in the least the character of the discoidal cell of the front wings. One of the antennæ, and particularly its club, is tolerably well preserved (Fig. 11), as is also a bit of the tongue; while one of the fore legs (Figs. 12, 13) is sufficiently clear to make out the joints, and to show by its aborted character that the butterfly must belong in the *Nymphalidæ*. That it was a male is indicated by the preservation of a part of the upper organ of the abdominal appendages. It is possible that a thorough scrutiny of an extended series of this family would enable one to decide, by correlating the structure of the antennæ and fore legs, in what neighborhood it should fall. But as this is not at present in my power, I have preferred to designate it provisionally by a generic name indicating merely its family relation, as is not

seldom required in the study of fossil insects. Nearly all the characters which will be given below are of a generic nature.

The body is very stout, while the head is comparatively small, and the tongue slender. The wings are very ample, with a pretty strongly arched costa to the fore pair, especially toward the base; none of the veins are swollen at the base, and nothing characteristic appears except that the ordinary form of superior apical branching seen in the subcostal vein of the fore wings of *Nymphalinae* appears also here. To judge from this forking the wing is apparently broken off just before its apex, and is about one and three-quarters the length of the body. The antennæ are short, being a little less than half as long as the wings, very slender, with a very gradually incrassated club (Fig. 11), which is nowhere double the thickness of the very slender stem, occupies nearly the apical fourth of the antennæ, and is composed of about fourteen or fifteen joints, which increase mostly in size in the basal half of the club, then scarcely increase, while the decrease is entirely confined to the last two joints and mostly to the ultimate, the extremity being well rounded and not at all produced; the joints of the whole club are of nearly equal length, and the largest about twice as broad as long. The fore leg (Fig. 12) is somewhat less than half as long as the antenna, tolerably stout, the tibia nearly as long as the femur, the tarsus somewhat shorter than the tibia, showing four joints, of which the first is somewhat shorter than the rest combined, and the last (Fig. 13) is armed with slender short spines. The last segment of the abdomen shows in the middle what appear to be the curving sides of the tapering hook of the upper organ, of the ordinary form.

This is the first instance in which the atrophy of the fore legs, so well known to be common to both sexes of recent *Nymphalidae*, has been shown to occur in a fossil form. That it should be less pronounced than in recent times is not surprising, and it is fortunate that we have independent, though not absolute, proof that the individual was a male. The amount of atrophy in size is about equal to what is found in the male *Lyceiidae* to-day, or possibly a little more. The femur is much less than half the size of the middle femur; the tibia, on the contrary, though not half so long as the middle tibia, is shorter than it, while the tarsus bears the proportion to its own tibia common to recent *Nymphalidae*, and the armature at tip is reduced to a few spines.

The stout body, ample wings, and the remarkably short and very slender antennæ, with their slight and gradually incrassated club, are found combined in no genus of butterflies found in temperate North America. *Timetes* and the genera allied to it (which are really Central American types, but invade our southern borders) perhaps approach nearest to it, and especially *Cymatogramma*, a Central American type; but all of these have much slenderer bodies than

are indicated here, and, so far as I have been able to examine them, have far slenderer fore legs. On the whole, however, I am inclined to place the fossil form in this vicinity, until at least further light can be obtained from additional specimens.

Expanse of wings as preserved, 55.5^{mm}; probable expanse of wings, 63^{mm}; length of body, 18^{mm}; of antennæ, 13^{mm}; of fore tibia and tarsus, 4^{mm}; of fore tibia, 2.2^{mm}; of middle tibia, 4.5^{mm}.

Florissant, one specimen, No. 7,768.

APANTHESIS (*ἀπανθήω*), gen. nov.

Allied to *Anelia* Hübn. (*Clothilda* Blanch.) and *Cirrochroa* Doubl. Front wing only known. It is subtriangular (PL LII, Fig. 13), and, excepting the strongly sinuate inner margin, of very simple form, the costal and outer margins being gently (the latter very gently) convex, and rather feebly crenulate between the nervules; there is hardly any basal curve to the costa. The costal nervure is crowded close to the subcostal and terminates nearly opposite the end of the cell or beyond the middle of the margin. The subcostal is generally parallel to the costal margin throughout its course, its first and second superior nervules originating near together before the end of the cell, the second as far before it as it is after the first, the third and fourth superior far apart and far from the basal offshoots, dividing nearly equally the distance beyond the cell, the fourth terminating at the tip of the wing; the first inferior subcostal nervule parts at the tip of the cell at a very slight angle from the nervure, continuing with great regularity to the outer margin, the curve of the subcostal nervure immediately before its origin; the second inferior subcostal nervule is very obscure at its origin, but apparently arises so close to the base of the first inferior nervule that there is practically no so-called upper disco-cellular nervule; the middle one is a little shorter than the lower and with it, also very obscure, lies in a nearly straight line, striking the median nervure nearly as far beyond the origin of the middle nervule as that beyond the basal. The discal cell is thus half as long as the wing, subquadrate in its outer, cuneiform in its basal half, and about three times as long as broad. The middle median nervule arises opposite the second superior subcostal nervule. The submedian vein is remarkably straight, considering the great sinuosity of the inner margin, and on the basal half of its course is nearly as distant from it as the nervules are from each other on the outer margin. Internal nervure wanting.

The markings consist of a uniform dark ground with a narrow banded series of pale sublunular spots, almost exactly parallel to the outer margin and much nearer it than the apex of the cell.

Without the other parts of the body to guide us, it is somewhat difficult, and perhaps a little hazardous, to venture any decided opinion as to the precise relationship of this fossil. That it is one of the

Nymphalidae and belongs to the tribe *Vanessidi* there can be no doubt; the structure of the subcostal nervure and its branches decides this at once. But this is a large group, and it includes a wide diversity of structural detail. Any one reviewing the matter will, however, be pretty clear that it either belongs in the vicinity suggested above or in the neighborhood of the other fossil butterflies of this tribe from Florissant, near *Symbrenthia* Hübn., and *Hypanartia* Hübn. The fullness of the outer margin, the size of the wing, and the deep sinuosity of the inner margin (the latter feature found in the neighboring genus *Polygonia* Hübn.), tell rather for its relationship to other Florissant fossils; but the length of the costa, giving a more pointed wing, the usual formation of the tip of the wing from the fourth rather than the third superior subcostal nervule (here very decided), with the mode of origin (not altogether unquestionable in the fossil) of the first inferior subcostal nervule, seem to place it rather in the neighborhood of the genera allied to *Anelia* Hübn. In both of these groups the first two superior subcostal veins arise near together, generally a little before the middle of the wing, while the third and fourth are far removed and distant from each other; but it is more common in the *Cirrochroa* or *Anelia* group for both of the first two, the second as well as the first, to arise, as here, before the end of the cell, even if the cell is short; and, as here, for the cell to extend as far along the costal as along the median system, if not indeed further. It would therefore appear that the weight of evidence is decidedly in favor of the alliance of *Apanthesis* with *Cirrochroa* and *Anelia* rather than with *Hypanartia* and *Symbrenthia*. Both of these groups, or rather series, are East Indian as well as tropical American in their distribution, but it is remarkable that *Anelia* is the only genus of the series which occurs in tropical America, where only it is found; while our fossil appears to be more nearly allied to the other genera about *Anelia* rather than to *Anelia* itself. I judge, therefore, that *Apanthesis* and *Anelia* belong to a failing group (for America), and the generic name has been chosen in accordance with this belief. It differs from all of the genera of this series in the origin of the second subcostal nervule some distance before the end of the cell, in the great length of the cell, in the distance of the subcostal nervure from the margin (in both these two last points *Anelia*, of all others, agrees best with it), and in the total lack of falcation to the wing from the fullness of the outer border. It differs entirely from *Anelia* in the course of the so-called discocellular veins, in the approximation of the costal to the subcostal nervure, and in the sinuosity of the inner margin, the last feature seen in a slight degree in *Cirrochroa*. In no one of the genera of this series, nor in those allied to *Hypanartia* (in the latter case, one may add, living or fossil), do I find any such pattern in the fore wing as occurs in *Apanthesis*. The nearest

approach to it is found in some species of *Cirrochroa*, such as *C. fuscata* Feld., of Sumatra, but that is still far removed. It may be said, however, that both in *Cirrochroa* and *Apelia* the more frequent markings generally are strictly parallel as here to the outer margin (though usually dark on a light ground), while in the genera of the other series they are ordinarily more or less at right angles to the costa.

APANTHESIS LEUCE,¹ sp. nov.

(Pl. LII, Figs. 12, 13.)

The ground color of the fore wing is a rich dark fuliginous brown, infuscated narrowly along the costal margin, and with the veins marked in fuscous. Parallel to the margin and at about three-fifths the distance from the apex of the cell to the margin is a connected series, broken only by the nervules, of pale transverse spots, arcuate or doubly arcuate on the lower interspaces, angulate on those beyond the cell, in all the larger interspaces at least twice as broad as long, reaching from the tip of the third superior subcostal nervule to the submedian. Midway between this band and the margin is a faint series of submarginal pale cloudings, scarcely definite enough to be called spots, of the same general form as those preceding them, but smaller and disconnected.

Length of fore wing, 34.5^{mm}; breadth of hind margin, 23^{mm}; length of cell, 17^{mm}.

Florissant; one specimen, No. 16,354, collected by D. P. Long.

Subfamily LIBYTHEINÆ.

PROLIBYTHEA (πρω Libythea), gen. nov.

The *Libytheinæ* form one of the most strongly marked and eccentric types of butterflies, the position of which has been a matter of some dispute among naturalists. The group is especially remarkable for the excessive length of the palpi, the antigenic structure of the fore legs, and the pieridiform larvæ. It seems to be rather the prevailing fashion now to consider them as a group of *Lemoniinae* placing them next the *Nymphalidae*, this opinion being based almost exclusively on the character of the fore legs. Others, whose opinion I share, would place them in the *Nymphalidae*, in the position nearest to the *Lemoniinae*, giving greater weight to the other general features of their structure, and particularly to the width of the head between the eyes. It is really only a question of which side of the boundary they shall be placed.

Without exception, authors have referred the species of this group, which are few in number, widespread, and have a characteristic common facies, to a single genus, *Libythea*. Other names, indeed, have been proposed for the genus, such as *Hypatus* and *Heceerge*, but with the purpose of their including all the species of the subfamily.

¹ Leuce was a nymph beloved of the god of the nether world.

Fore wings (Fig. 20) with the last two superior subcostal nervules originating near together, midway between the cell and the apex of the wing, fully twice as distant from either as from each other; upper median interspace nearly as broad at base as at apex; outer margin sharply angulate at the lowest subcostal nervule, below which it is scarcely crenulate.

Color-design of fore wing, beyond the basal patches, formed of a pair of spots depending from the costal margin nearly half way from the cell to the apex, and a subapical patch just above the median nervules.

Hind wing with a pronounced rounded lobe above and at the apex of the costal nervure; outer margin angulate-crenulate, the projections at the nervules; anal angle at the tip of the submedian nervure rectangular.

Eighth abdominal segment of male deeply bifid, the two sides produced to a pair of tapering processes; male claspers forming a pair of elongated, irregular, prickly incurved forceps.

CATERPILLAR uniformly cylindrical throughout.

CHRYSA LIS with the anterior extremity simple, there being no apical notch dividing the head.

The wide distribution of this type of butterflies is, considering its poverty in forms, most remarkable. They are found on every continent, though they are confined to the tropics and the adjacent countries. The metropolis of the group appears to be the archipelago and borders of continents lying between India and New Caledonia, but species also occur in Ceylon, Mauritius, western Africa, and on the shores of the Mediterranean; in the New World, they are found exclusively east of the Cordilleras, between the equator and 45° north latitude, including the tropical islands.

Considering the oddity of this type of butterflies and their curious distribution over the world, it is interesting to find not only that the fossil we have next to discuss falls in this group, but that it combines in its structure features which are characteristic, now of *Libythea*, now of *Hypotux*. Following in the order of distinctions given above,

Fore wings (Fig. 21) with the last two superior subcostal nervules originating rather far apart, dividing the subcostal nervure beyond the cell into three subequal portions; upper median interspace narrowing considerably toward the base; outer margin bluntly angulate at the lowest subcostal nervule, below which it is crenulate, the projecting portions in the interspaces.

Color design of fore wing, beyond the basal patches, consisting of an oblique band or series of adjoining spots depending from the costal border, immediately beyond the cell, a subapical patch in the upper median interspace and another in the upper inferior subcostal interspace; the whole series nearly encircling the region occupied by the markings in *Libythea*.

Hind wing with the costal margin altogether entire, there being not the slightest prominence at the tip of the costal vein; outer margin gently crenulate, the projections at the nervules; anal angle before the tip of the submedian nervure rounded.

Eighth abdominal segment of male laterally angulate, the middle produced to a large tapering hook; male claspers forming a pair of broad and unarmed flattened valves or plates.

CATERPILLAR cylindrical, but thickened on the thoracic segments.

CHRYSA LIS with the anterior extremity notched, and so furnished with a double protuberance.

we find it has very slender antennæ (Pl. LIII, Figs. 4, 5, 6, 8), with a distinct though greatly elongated club, comprising about a fourth of the whole antennal length, by which it is distinctly allied to *Hypatus*. On the other hand, when we consider the palpi (Figs. 6, 8) we find them modeled on the plan of *Libythea*, with a comparatively short apical joint, which (if we assume the length of the middle joint to be, as in both the modern genera, equal to the width of the head, including only one eye) is only a third longer than the second joint. In the neururation of the fore wing it most resembles *Libythea* in that the outer two superior subcostal nervules are approximate at base, though in other features of their position they differ from both. In markings it is plainly closer to *Libythea*, since the oblique band depending from the costal margin is well removed from the apex of the cell (Fig. 9) and the lower submarginal patch is above the medium interspaces. The hind wing (Fig. 9) has a pronounced costal lobe above the apex of the costal nervure, thus resembling *Libythea*, and, as there, what portion of the outer margin is preserved is heavily crenate; but the anal angle falls in the medio-submedian interspace, as in *Hypatus*, and not at the apex of the submedian nervure as in *Libythea*. None of the other features distinguishing *Libythea* from *Hypatus* can be made out; but enough has been said to show the remarkable intermingling of characters, and to prove that we have here, in all probability, the common ancestor or one of the immediate ancestors of both the modern genera. There must, however, have been more than one stage between it and our existing American species. As it plainly can not be considered in strictness a member of either, and has some characteristics of its own, besides a wholly different combination of characters from the living forms, I propose for it the name of *Prolibythea*. Its distinctive features, besides those above mentioned, which it shares with one or the other of the modern types, are the extreme slenderness and brevity of the antennæ, which are even slenderer than in *Hypatus* and are rather less than two-fifths the length of the fore wing; the point of origin of the outer two superior subcostal nervules of the fore wings, the outermost being midway between the cell and the apex, instead of being about as far beyond that point as the penultimate is before it, as is the case both in *Libythea* and in *Hypatus*; and finally in the indication of an excessively dentated margin to the hind wings, at least posteriorly. The bulk of its features are thus seen to bring it into much closer alliance with *Libythea* than with *Hypatus*, and we have the curious circumstance of a Tertiary butterfly from the heart of North America belonging to a group of which only a widely dissevered fragment now exists dispersed all over the globe, yet a butterfly which is more nearly allied to forms existing now in distant parts of the earth, separated from its ancient home by wide oceans, than to forms of the same stock on the same continent.

I might add that an examination should be made especially of the African *Libythea lubdaca* Westw., the only modern species agreeing with the fossil in size, to see whether it should not fall in *Prolibythea*. As figured in Doubleday and Westwood's Genera of Diurnal Lepidoptera, it differs decidedly from other species, and seems to agree more closely than any other to our fossil (see page 469). The antennæ are represented as almost precisely like those of the fossil, being exceedingly slender, about two-fifths the length of the fore wings, with a distinct and comparatively short club, and the shape of the margin about the anal angle of the hind wings with apparently the termination of the submedian nervure is identical with the fossil species and quite different from the same part in all other species of which I have seen specimens or illustrations.¹

PROLIBYTHEA VAGABUNDA, sp. nov.

(Pl. LIII, Figs. 4-9.)

The specimen to which this name has been given shows the body and appendages of a butterfly lying upon its back (Pl. LIII, Fig. 4). The antennæ and wings of the left side (as seen) are lost and the specimen itself has been twice broken across, to the loss of small portions of the wings. The wings overlap almost completely, and such markings as they may have had are exceedingly obscure; but the greater part of the neurulation and some important features of the color pattern can be made out (Fig. 9), together with most of the margins, though the outer margin either received severe abrasion before sepulture or is imperfectly exhibited through the conditions of deposition. The palpi, one antennæ (Figs. 5, 6), and parts at least of nearly all the legs are preserved, the nature of the front pair (Fig. 7) showing, with the very full and equal abdomen, that the specimen was a female.

Most of the features of its structure are such as have come into notice in discussion of its generic relations, but a few further details which are more specific in nature may be added. The fore wing has the costal margin very regularly and gently convex; that the outer margin is produced to a sort of falcation at the lowest inferior subcostal nervule, as in all existing members of the subfamily, is shown by the course of the margin above and below that point; but whether this falcation is as strong as in *Libythea* proper, as made to appear in the restoration (Fig. 9), is not certain; it is clearly emarginate above this point, however, and not, as in the modern African species, entire. In the hind wing the costal margin is preserved entire, and is formed on the general fashion of that of the Mediterranean *Libythea celtis*, although the lobe is not so prominent and

¹ I have seen all but the species of Mauritius, Ceylon, and one of those of the Malay Archipelago.

not so far removed from the base of the wing; or rather the wing is not, as in *L. cellis*, extended so far on the line of the subcostal nervules, as is shown not by the exact demarkation of the wing at this point on the fossil (for its precise margin is obscure), but by the faint clouding of the stone which marks its approximate border. This part of the wing accords better in its outline with that of our own *Hypatus Bachmani* or the African *Libythea labdacu*; with the latter of which it agrees as it agrees with no other member of the subfamily, so far as I can discover, in the outline of the hind wing below the middle median nervule, a margin which is perfectly definite in the fossil, and one which is remarkable for the lobe-like extension at the lower median nervule, found nowhere else.

The markings of the wings are altogether obscure, though one important point can be fixed in the markings of the apex of the fore wing, where it is not overlapped by the hind wing. This is a light subtriangular patch (Pl. LIII, Fig. 9) depending obliquely outward from the costa at fully its own width beyond the cell, with possibly a couple of small subquadrate spots just outside its outer limit in the lowest inferior subcostal and subcosto-median interspaces. It should be noted that these spots occur more as in *Libythea* than as in *Hypatus*, excepting that in the relative position of the upper series beyond the cell they fall midway between the two genera. The lower series is far nearer the cell than in any other member of the subfamily.

The palpi are well represented in Fig. 6, and the antennae in Fig. 5. The latter show the separation of the naked surface from that covered by scales, in the latter of which the three slender carinae extending the whole length of the club and even upon the stalk in all members of this group I have examined carefully can be made out in certain parts. The middle tibiae are furnished with three or four rows of short recumbent spines, arranged in very definite series, as is not clearly shown in Fig. 7, each spine just failing to reach the base of the next; those at the end of the tibiae are larger. The tarsi are clothed in an entirely similar way and show the claws at the tip, which are small, delicate, and moderately curved.

The butterfly is larger than common in the subfamily, the expanse of wings being even slightly more than in the African species, itself one of the largest, if not the largest, now living.

Length of body, including palpi, 31.5^{mm}; of last joint of palpi, 3.25^{mm}; of antennae, 11^{mm}; of antennal club, 3^{mm}; width of latter, 0.45^{mm}; of stalk, 1.5^{mm}; length of fore wing as preserved, 28^{mm}; as restored, 29.5^{mm}; probable expanse of wings, 63^{mm}; greatest breadth of fore wing, 18^{mm}; of hind wing, 19^{mm}; length of fore tibia and tarsi, 3^{mm}; of middle tibia and tarsi, 4.5^{mm}.

As all the species of this subfamily from Europe and North America are known to feed, when caterpillars, upon *Cellis*, it is inter-

esting to note that Lesquereux has found among the plants of Florissant two perfectly well preserved leaves of a very fine *Celtis* (*C. Maccoshi* Lesq.), whose generic relations are positively ascertained. With them were also found fragments of flowers which could have been readily admitted as of the same species. It is, therefore, highly probable that *Prolibytha vagabunda* fed on *Celtis Maccoshi*.

The specific name is in allusion to the far-away immediate allies of the fossil, and its relation to a vagabond type.

Florissant, one specimen, No. 16,353.

Family PAPILIONIDÆ.

Subfamily PIERINÆ.

Tribe PIERIDI.

STOLOPSYCHE ($\sigma\tau\acute{o}\lambda\omicron\psi\chi\epsilon$, $\sigma\acute{o}\lambda\chi\tau$), gen. nov.

A medium sized pierid, with small head, rather large thorax, and ample wings. Front of head clothed with a rather thin mass of rather short hairs not reaching beyond the base of the apical joint of palpi. Antennæ (Pl. LIIL Fig. 2) slender, about two-fifths as long as the fore wing, all the joints remarkably short, and those just beyond the base no longer than broad, the very slender and very gradually enlarged club occupying nearly a third of the whole antenna. Palpi (Fig. 3) very slender and exceptionally long, being two and a half times as long as the eye, the apical joint nearly double the middle in length, and considerably exceeding the basal joint, the two basal joints furnished beneath with a thin fringe of long hairs, rather longer below than above.

Fore legs only a little shorter than the middle pair, the tibiae being from three-fifths to two-thirds as long as the femora, and about equal to the first joint of the tarsi or the remaining joints combined.

The small head combined with the large and arched thorax and long fore legs, show that this insect must belong to the *Pierinae*, and its slender, long, and porrect palpi mark it as referable to that division of it, the *Pieridi*, to which the "Whites" belong—a conclusion well borne out by the length of the apical joint of the palpi and the character of such ornamentation as it has, while the structure of the antennæ is more nearly allied to that of the *Rhodericidi*. It seems to agree well in general appearance, size, and in the proportions of the fore legs with *Pieris*, using this term in the most restricted sense, and to be indeed more closely related to it than to any other living genus of *Pieridi*; but it differs strikingly from it and from all others in the excessive length of the labial palpi, the extreme brevity of the basal antennal joints, and the character of the club. In the latter point it certainly shows a passage toward *Eurymus*. Little direct comparison can be made between it and the only other known fossil butterfly.

of this group, *Pontia freyeri* (Heer) from Radoboj, since the only fragment of that species consists of a wing, while here the wings are not only incomplete, but are badly preserved. It is, however, highly probable, from the absence in this fossil of the *Pontia* pattern of that from Radoboj, that the two are generically distinct, though they are doubtless nearly allied. The neurulation is badly preserved in both.

STOLOPSYCHE LIBYTHEOIDES, sp. nov.

(Pl. LIII, Figs. 1-3.)

The species is represented by a single specimen, the wings of which are badly preserved and the outer margin broken off, though parts of the body sufficient for generic determination can be made out with pains. The insect appears to have been about as large as *Pieris rapæ* Linn., but with relatively smaller head, larger thorax, and much larger palpi, and to have possessed wings generally resembling those of *Pieris* in form excepting in having a less arched costal margin. In markings the wings seem to have been white, or at any rate very pale, and on the under surface of nearly uniform coloration, with no blotches or spots of darker color anywhere (such as occur in the fore wing in the median or submedian interspaces in *Pieris rapæ*, or depending from the costal margin at the apex of the cell in *Pontia* or *Neophasia*), but to have had all its markings confined to the nervures or margins, and, with the exception of a moderately broad costal edging, to the nervures of the hind wings, all of which, like the costal border of the fore wings, appear to have been traced in grayish or griseous streaks. Whether, as in *Ascia* and some others, there was any black edging to the outer margin or an apical patch can not be told, as the stone is broken so that the outer margin is not preserved.

The probable length of the fore wing was 25^{mm}; length of palpi, 1.5^{mm}; of antennæ, 10^{mm}; of fore tibia and tarsi, 7.2^{mm}; of middle tibia and tarsi, 8.5^{mm}.

The specific name is in allusion to the great length of the palpi. Florissant, one specimen, No. 11,077.

APPENDIX.

After this paper was written, I learned that a single specimen of the little known *Libythea labdaca* of West Africa was in the collection of Rev. W. J. Holland, of Pittsburgh; and he has kindly taken the greatest pains to answer all my questions regarding its structure, and of his own motion to send me excellent enlarged sketches of different organs. From these I find that my conjecture that of all living forms it would be found nearest the fossil *Prolibythea* proves entirely correct. The antennæ are remarkably slender, with a distinct club, composed of about 14 to 15 joints, and comprising not more than one-fifth of the whole antenna, which is itself just two-fifths the length of the fore wing; the terminal joint of the palpi is nearly if not quite twice as long as the middle joint; the last two superior subcostal nervules of the fore wings are widely separated at base; and the base of the upper median interspace of the fore wings is considerably narrowed, though not to a great distance. In all these characters it agrees with *Hypatus*, and not with *Libythea*; in all (excepting, perhaps, the characteristic of the upper median interspace, which is unknown in the fossil) it agrees entirely with *Prolibythea*. It also agrees with *Prolibythea*, and with *Libythea* rather than *Hypatus*, in the more nearly entire margin of the lower half of the fore wings and the distinctly crenulate outer margin of the hind wings. It is allied to *Prolibythea*, and to neither of the modern genera mentioned, in the tail-like prolongation of the lower median nervule of the hind wings. In the termination of the submedian nervule of the same wings, rather within than at the anal angle, it comes between the European and American (fossil and recent) forms; while in only one feature, the entire, unlobed costal margin of the hind wings, does it agree better with *Hypatus* than with *Prolibythea*. These peculiarities show that it is more nearly allied to *Prolibythea* than to any modern genus; it should not, however, be referred to that extinct type—not simply on account of the differences in the margins of the wing mentioned above, but for several features in the wing-structure, in which it disagrees with all modern types (Fig. 22). In the fore wings, the outer margin is peculiar in the near approach to parallelism of the portions above and below the sudden change of course above the upper median nervule common to all *Libytheinæ*; the last two superior subcostal nervules are very far apart, the middle of the thirds into which they divide the subcostal nervule beyond the extremity of the cell being longer than either of the other (subequal) thirds, while in all other *Libytheinæ* it is shorter; the form of the outer half of the hind wings is wholly peculiar, due to the prominence of the upper sub-

PLATE LII.

FIG. 1. *PRODRYAS PERSEPHONE*; showing the left half of the body in outline with the venation and the position of the markings, the wings being separated slightly more than in the specimen, to allow the venation to be more readily distinguished. †

2. THE SAME; showing the left antennal club, the naked being clearly distinguished from the squamous portion. †

3. THE SAME; the club of the right antenna, turned in the fossil so as to show only the squamous side. †

4. THE SAME; the palpi, magnified. †

5-9. THE SAME; scales from different parts of the right fore wing, those of Fig. 5 occurring between the lowest subcostal spot and those in the subcosto-median interspace; Fig. 6 in the basal half of the upper submedian interspace just before the spot; Fig. 7 some scales close to the apex of the wing; and Fig. 8 on the costal margin, half way between the outer row of spots and the tip. The figures are drawn as they appear reversed under the microscope. †

10. THE SAME; showing the whole fossil. †

11. *LITHOPSYCHE STYX*; showing the margins and veins of the overlapping wings and the edges of the spots as they appear on the wing as preserved. †

12. *APANTHESIS LEUCE*. †

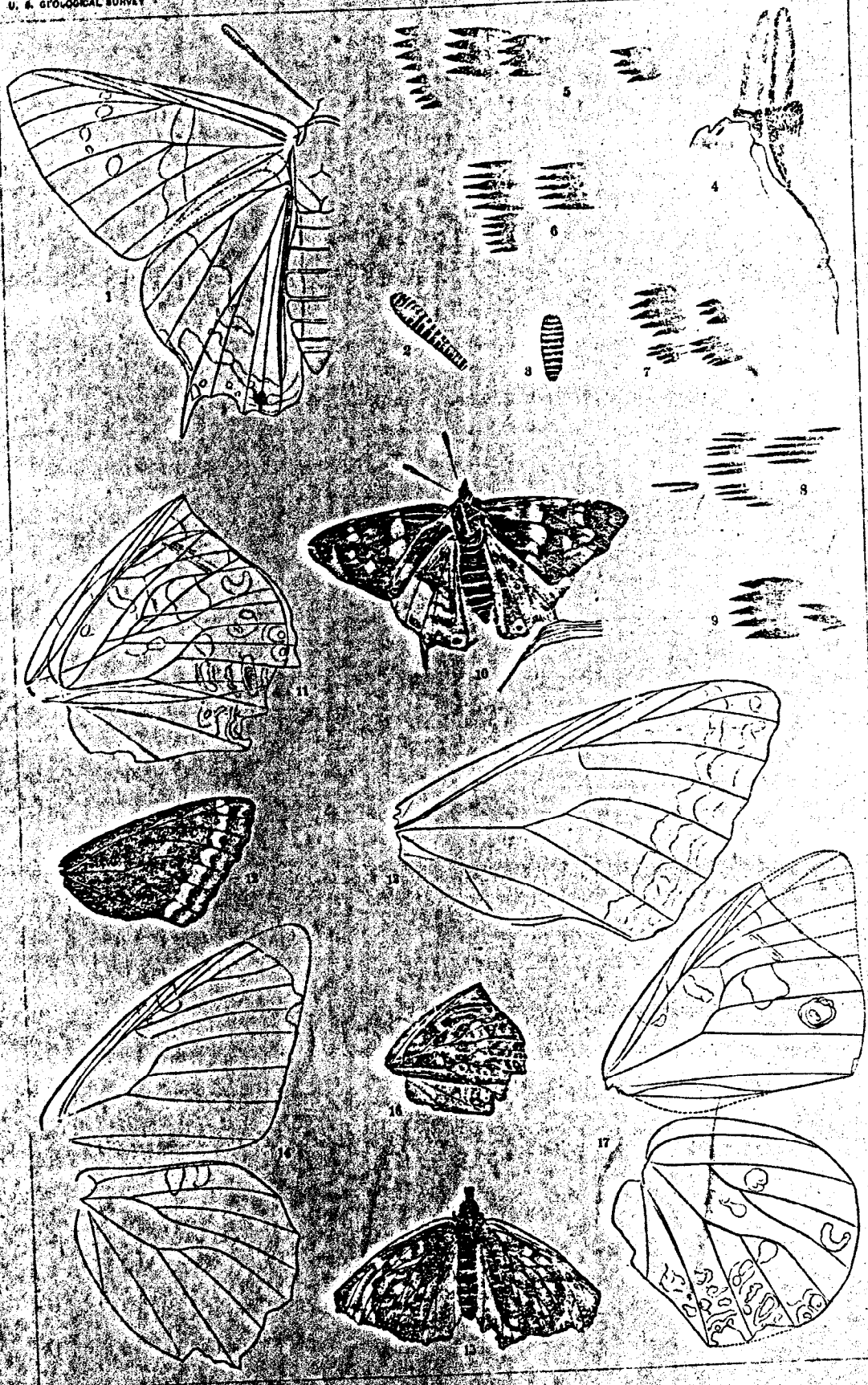
13. THE SAME; showing the venation and the position of the markings. †

14. *JUPITERIA CHARON*; the venation and margins of the separated wings, with the limits of such markings as are unquestionable. †

15. THE SAME; showing the appearance of the fossil with its overlapping wings. †

16. *LITHOPSYCHE STYX*; the specimen as it appears. †

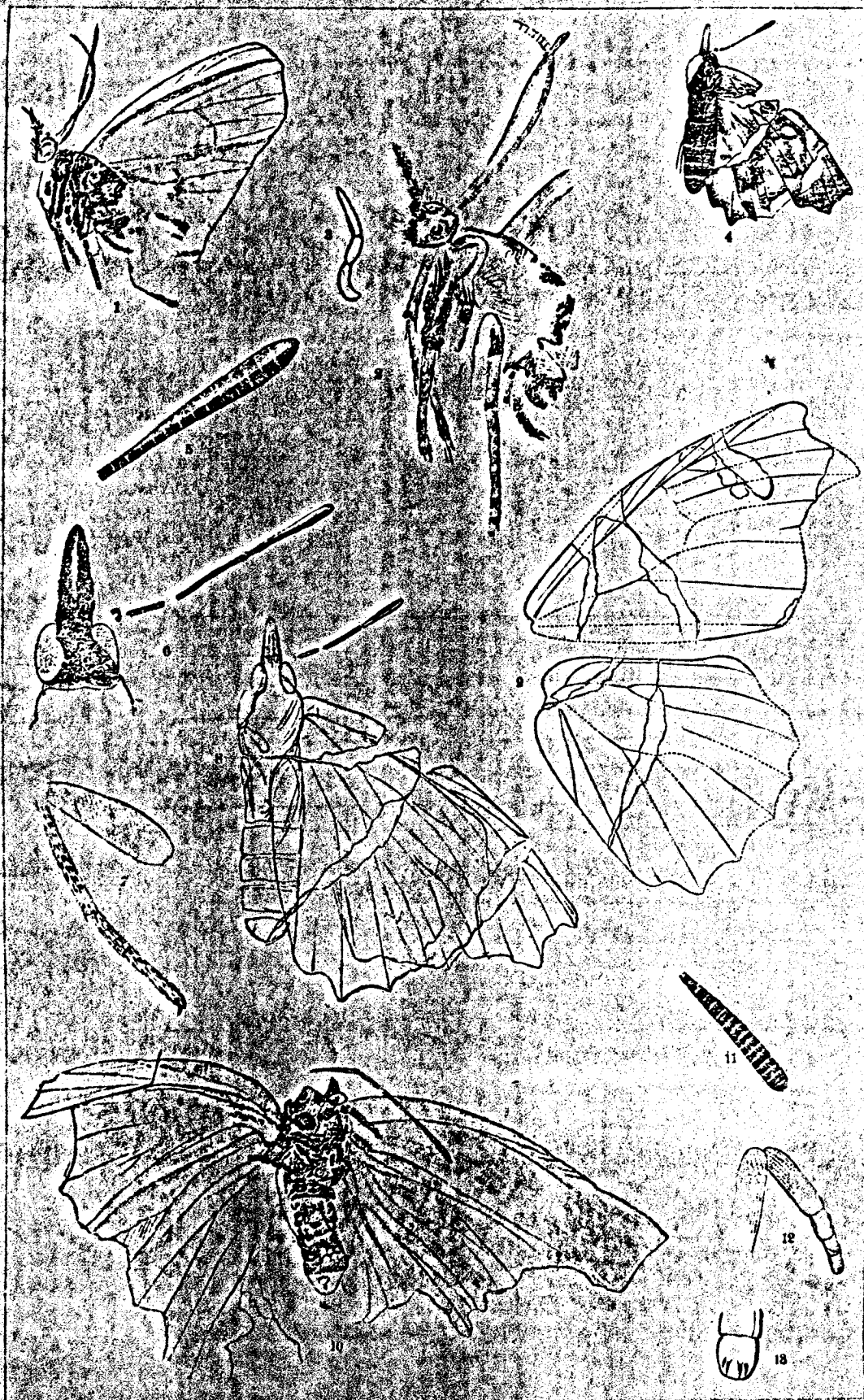
17. THE SAME; showing the margins, markings, and venation of the separated wings, with the tip of the fore wing restored. †



THE FOSSIL BUTTERFLIES OF FLORISSANT, COLO.

PLATE LIII.

- FIG. 1. *STOLOPSYCHE LIBYTHEOIDES*. †
2. THE SAME; showing more details of the structure of the antennæ, palpi, and legs. †
3. THE SAME; the palpus, as it would appear if denuded. †
4. *PROLIBYTHEA VAGABUNDA*. †
5. THE SAME; showing the details of the structure of the antennal club, as far as they can be made out. †
6. THE SAME; showing the head and its appendages. †
7. THE SAME; the fore leg, showing spines and terminal claws. †
8. THE SAME; drawn in outline to show the veins as they appear in the overlapping wings of the fossil, with the position of the other features of the body. †
9. THE SAME; the wings detached, and the venation and margins shown separately and thus clearly; dotted lines indicate the parts which are restored. †
10. *NYMPHALITES OBSCURUM*. †
11. THE SAME; the club of the antenna enlarged to show its composition. †
12. THE SAME; the front leg, with the tarsal joints. †
13. THE SAME; the terminal tarsal joint of the fore leg, showing the spines which take the place of the normal claws. †



THE FOSSIL BUTTERFLIES OF FLORISSANT, COLO.